Solidification Behaviour and Theraml Conductivity of Bulk Sodium Acetate Trihydrate Mixtures with Thickening Agents and Graphite Powder

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Solidification Behaviour and Thermal Conductivity of Bulk Sodium Acetate Trihydrate Mixtures with Thickening Agents and Graphite Powder

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Abstract:

Sodium acetate trihydrate (SAT) is an interesting phase change material (PCM) for long term thermal energy storage as it allows to store heat partly loss free in the meta stable supercooled state. The low thermal conductivity of sodium acetate trihydrate limits the heat exchange capacity rate to and from the heat storage. Another factor that limits the heat transfer is the contraction and expansion of the salt hydrate during the phase change. This density change will cause formation of cavities inside the solid PCM. The behaviour of samples that crystalized from a supercooled state was compared to samples that crystalized with a minimum of supercooling. Samples that crystalized without supercooling tended to form solid crystals near the heat transfer area and a large cavity in the centre. Samples that crystalized from supercooled state formed fewer large cavities. The thermal conductivity was up to 0.7 W/mK in the solid parts. For samples that formed a high number of smaller cavities the thermal conductivity was 0.3 W/mK.

Motivation:

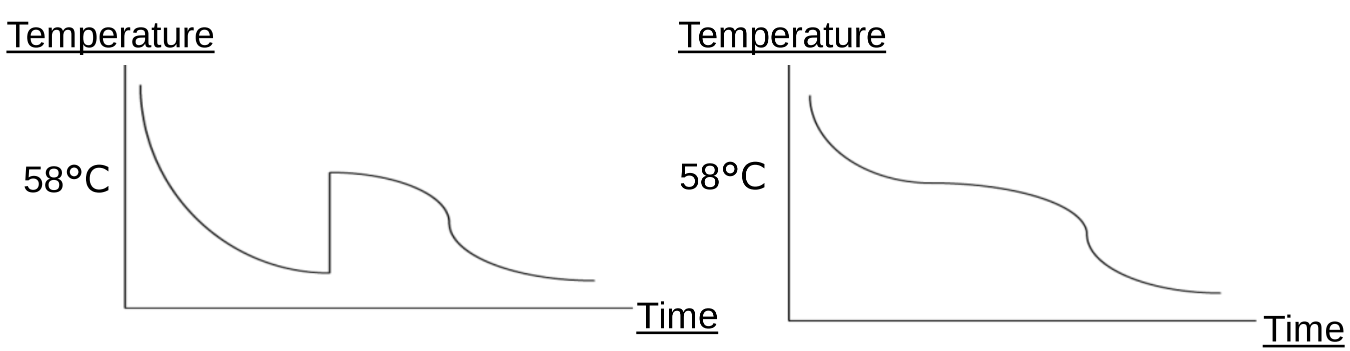
Traditionally one of the limiting factors in using phase change materials in heat storage systems is the low thermal conductivity of the PCM itself. Literature values for the thermal conductivity of solid SAT range from 0.4 W/mK to 0.7 W/mK. The thermal conductivity has previously been sought improved by adding graphite to PCMs. To do numerical calculations and simulations an accurate value for the thermal conductivity of the PCM in bulk sizes that resemble the usage in full scale applications is desired.

Method:

- 1.3 kg SAT mixtures in closed glass jars.
- 9-10 cm height; 12 cm diameter.
- 2 repetitions of each sample, one with and one without supercooling.

Sodium Acetate Trihydrate	SAT + 10% H_20	SAT + 1% Carboxy Methyl Cellulose	SAT + ¼% Xanthan rubber	SAT + ½% Xanthan rubber + 5 % graphite powder

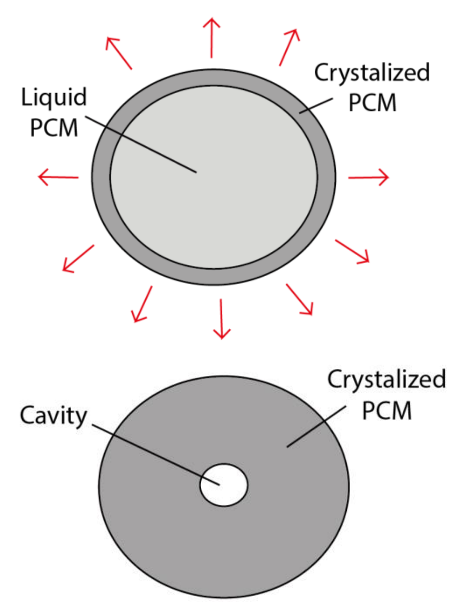
- Samples were prepared and melted in an oven at 90°C.
- One of each sample was set to supercool to ambient temperature, after which the crystallization was started by seeding a crystal.
- The other of each sampled was seeded with a crystal once the melting temperature of 58°C was reached during the cooling down.

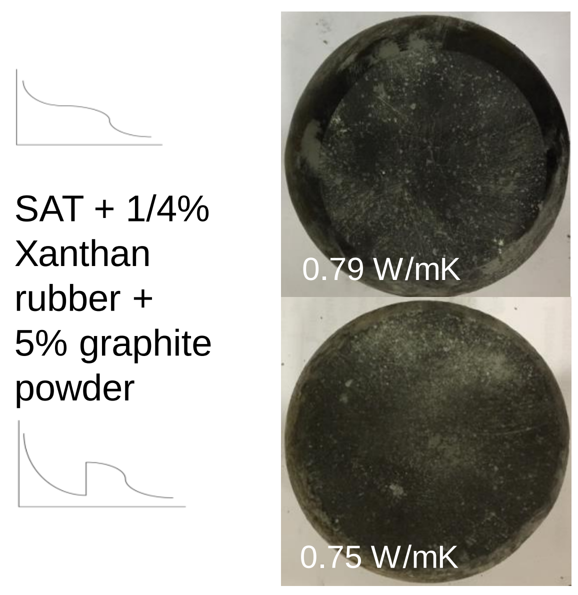


- Thermal conductivity measured by the **Hot Disc method:**

ISOMET Heat transfer analyser model 2104 from Applied Precision Ltd.

Results:





Conclusions:

Cavities forming during crystallization of PCM mixtures will influence the effective thermal conductivity of the solid. Samples that solidified without supercooling tended to form larger cavities in the centre and more solid crystals with higher thermal conductivity near the perimeter of the container. Samples that solidified from a supercooled state formed fewer large cavities and tended to have lower thermal conductivity near the perimeter of the container.

Acknowledgement:

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